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Comparison of Shear Forces in High-Top and Low-Top Basketball Shoes During Lateral Cutting Movements

Scott Turner

BOISE STATE UNIVERSITY

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Scott Turner
Center for Orthopaedic & Biomechanics Research, Boise State University, Boise, ID, USA

Abstract

Literature exists examining the effect of athletic shoe design on ankle sprains, specifically ankle inversion angles (Barrett & Bilisko, 2012). However, no studies were found that examined either shoe design's effect on the forces that occur at the ankle joint from lateral cutting maneuvers. The purpose of this current study is to measure the shear forces on the ankle during lateral cutting movements that are consistent with ankle inversions among high-top and low-top basketball shoes. It was hypothesized that there would be a greater amount of force on the ankle in low-top basketball shoes. Data was collected on eight participants, four wearing a low-top shoe, and four wearing high-top shoes. Kinematic data was collected via an 8-camera Vicon Nexus motion capture system (120 Hz) and kinetic data was collected via two in-ground AMTI force plates (2,400 Hz), on a lateral cutting movement commonly used in basketball. An independent T-test tested for significant differences in ankle joint force between HT and LT basketball shoes for each movement type. No significant difference was found ($p > 0.05$) among closeout or slide movements. Significant difference in force was seen between HT and LT shoes during crossover movement. Data suggests that while each shoe design relies on different support mechanisms, neither design of shoe decreases the amount of force on the ankle's anatomical structure.

Introduction

Literature exists examining the effect of athletic shoe design on ankle sprains, specifically ankle inversion moments (Barrett & Bilisko, 2012). It has been shown that the rate and total amount of inversion is lower in high-top (HT) athletic shoes vs low-top (LT) athletic shoes (Ricard & Schulties, 2000). Shoe height has also been shown to increase the active resistance on an inversion moment on the ankle in moderate ankle plantar flexion (Ottaviani, Ashton-Miller, Kothari, & Wojtys, 1995). The forces that cause the ankle to overly invert is due to players awkwardly landing on unexpected objects, often another player's foot. Ankle inversion can also be caused by other lateral body movements. Shear and torsional forces in these type of movements have not yet been evaluated; previous studies have only examined kinematic differences between shoe types.

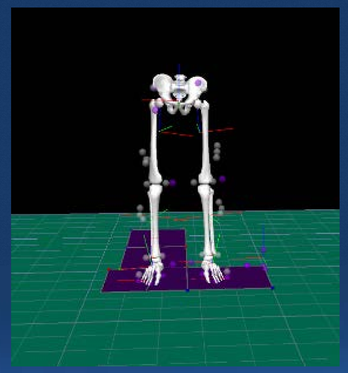
The lack of literature examining lateral movement forces on the ankle joint demonstrates the need for analysis of shoe type in reduction of shear force on the ankle. The purpose of this study is to compare shear forces on the ankle joint in lateral cutting movement between HT and LT basketball shoes. Because shoe height has been shown to increase active resistance of an inversion moment, it was hypothesized that high-top shoes would have lower force values compared to low-top in lateral cutting movements.

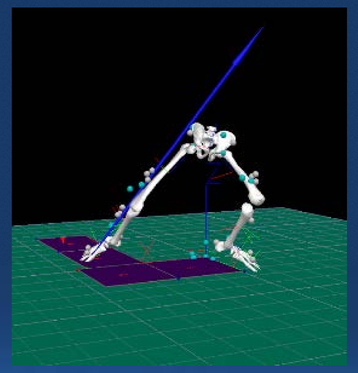
Methods

Seven male and one female participant were recruited for this study. All participants were between the ages of 21 and 26. All participants had at least 3 years of basketball experience. Participants were assigned to two groups depending on whether they wore high-top (HT) or low-top (LT) basketball shoes (HT, n=4; LT, n=4)

Participants completed a general warmup which consisted of jogging on a treadmill for 4 minutes at 5.0 mph. Participants were then instructed on the three lateral cutting movements that they would complete. The three movement types were a dribble crossover, a defensive closeout, and a defensive slide. It was emphasized to each participant the importance of completing each movement at full speed. This is needed to replicate actual movement forces that are experienced during basketball practices and games. A 19 piece lower body marker set including marker clusters was applied to all participants in order to collect 3D motion capture data. The participant then completed five trials for each of the three movement conditions, totaling 15 total trials per participant. Each trial required the participant to change direction on an in-ground force plate (Kistler, New York, USA). This force plate was used to calculate peak ground reaction force of their leg during the lateral cutting movement.

This data was collected using an 8 camera Vicon Nexus system (Vicon Motion Systems Ltd., United Kingdom). Camera collection rate was 120Hz. Force plate collection rate was 2,400 Hz. Motion capture and force plate data was analyzed using Visual 3D analysis software (C-Motion Inc., Maryland, USA). Kinematic data was filtered in Visual 3D using a bidirectional, Lowpass Butterworth (6 Hz) filter. Kinetic data was filtered using a bidirectional, Lowpass Butterworth (25 Hz) filter. Peak ankle force was calculated using the Visual 3D analysis software. An independent, two-tail T-test was done for peak ankle force between HT and LT shoes for each movement condition.

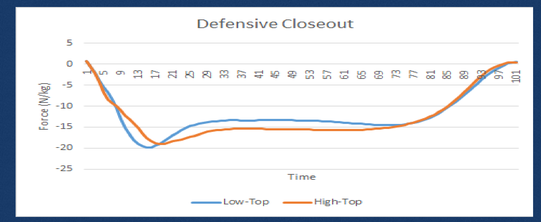


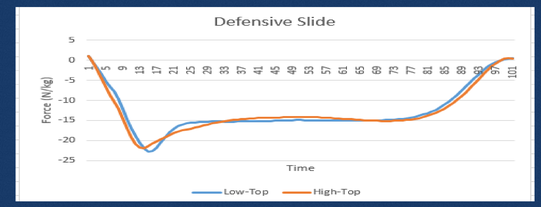


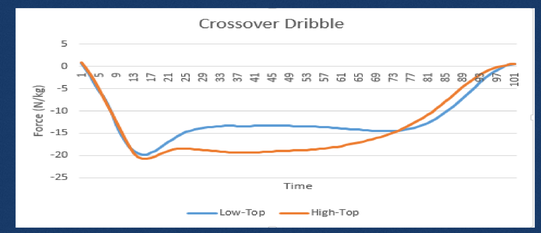
Bone models of each participant (left) were built using Visual 3D analysis software to analyze motion capture trials (right)

Results and Discussion

No significant difference in peak force was seen between HT and LT shoes in both the closeout and slide lateral cutting movements ($p > 0.05$). Significant difference in force was seen in the dribble crossover movement.







Force during each frame was averaged from all trials to create a graph of mean force over time for each movement condition

Conclusion & Future Research

The results of this study do not definitively support or contradict the hypothesis. Difference in force was seen in some movements and not in others. A larger sample size and having each participant complete the protocol in both HT and LT shoes may have led to the data conclusively supporting or not supporting the hypothesis. The Data does suggest that while each shoe design relies on different support mechanisms, neither design of shoe decreases the amount of force on the ankle's anatomical structure in closeout and slide movements.